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MASTER OF MILITARY STUDIES

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**TITLE:**

**Energy Security Through 2030: Some Considerations 2009**

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF MILITARY STUDIES

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## Executive Summary

Name: Major Jeffrey P. Scofield, USMC

Title: **Energy Security By 2030: Diversification Efforts Now**

Thesis: The efforts established by the current energy policy do not put the United States, and the global community for that matter, on a course that will result in adequate independence of fossil fuels by 2030. In order to secure its energy security, the United States must achieve diversification both in source types of energy production and in supplier of fossil fuels.

Discussion: Since M. King Hubbert introduced the concept of peak oil in the mid-1950s,[1] there has been significant discussion among the experts that one day the world will expend its available fossil fuels. Peak Oil defines the point in time of the maximum rate of global petroleum extraction. That estimated point in time is based upon an estimated rate of future consumption, known supplies, and potential discoveries. Since the 1970s, global consumption rates have far exceeded any predictions and continue to outpace even contemporary estimates. Additionally, exploration by the oil companies has discovered multiple fields over time, expanding the otherwise limited estimate of availability. Technology has improved the ability to extract difficult to access resources. Human beings consumed an estimated 50% of the earth's fossil fuel resources in the initial 100 years of the internal combustion engine. As we accelerate toward the wall of fossil fuel scarcity, political and perhaps military influence will be wielded to secure the more easily accessed resources. Despite the concept of peak oil, near-term there are also short term problems that will affect the ability to extract oil quickly enough to meet the world's increasing energy needs. This near-term problem of extraction capacity is compounded by the ability of the international market to refine oil at the rate of consumption created by a significant handful of rapidly developing nations; China and India, for example.

Conclusion: The transitional period as we approach the wall of Peak Oil will be more violent the shorter it is. To limit this effect, the United States must start to lead the way away from total dependence on fossil fuels as a source of energy. Our national security depends on a well-diversified energy source profile from two perspectives. The first perspective is the type of energy we use – fossil fuel, nuclear, and renewable. The second perspective is which and how many countries we import oil from.

**Preface: Diversifying Our Energy Profile**

A comprehensive energy security policy requires careful investments in both energy production and transmission, precisely targeted price and tax incentives focused on dependable distribution and efficient use of resources, financial action that provides resources to burgeoning alternative energy companies, and infrastructure investments to build the capability to extract and transport energy in a useable form. This paper will examine key characteristics of non-fossil fuel energy sources and several political situations of interest to the United States to determine whether we are heading for energy security or if we will surrender the initiative to other countries.

There are two issues at the heart of energy security. These issues are the end of the oil resource entirely, and the near-term limited capability to produce enough to keep up with increasing global demand. Both significantly limit supply and therefore the stability of the global oil market. Significant debate surrounds the issue of peak oil and whether or when the global supply of oil will be depleted to the point of causing global financial panic. A significant element during this critical period of production development is the limited ability to refine oil at the required rate to keep up with the trends of global demands. The restricted supply and the cost of increased investment in technology will result in a slow but persistent increase in the price of oil. The new market price allows oil companies to return to old, disregarded fields that have suddenly become affordable to exploit. Increased prices will open the door wider to new investment in new technologies.[2] In the near term as this undulating price story unfolds, turbulence will occur as oil rich countries flex their muscle and attempt to control flow and therefore oil prices. Their power will increase as the availability of world-wide oil decreases.

The United States, with all of its entrepreneurial energy and depth of capital investment potential, is in a great position to lead the way in the development of renewable and nuclear sources of energy through a diversification of its portfolio. Whether or not there is a future end to the oil supply, it is still in the nation's best interest to curb its appetite for oil. Its vulnerability to exaggerated price fluctuations is risky to its national security. When the race for oil becomes a matter of survival for world powers, it is in the United States' best interest to achieve superior technology development and implementation. From the position of the oil-independence, the United States will maintain its position of leadership as it leads the world away from armed conflict and toward a world-wide oil-independent energy structure. With our resources and consumer demand, correct application of carefully selected policies can vault this country into a position of relative fossil-fuel independence. On the other hand, with a lack of focus and poorly managed incentives the United States could lose the seat as world power to other, more focused and organized countries.

I would like to thank Dr Adam Cobb for his mentorship and guidance throughout this process. His command of both history and contemporary issues, as well as his faith in the institution, are inspirational. His example will encourage professional growth and excellence for classes of Marines to come.

I would also like to thank my family for their support through this accomplishment, but I would especially like to thank my wife for the many hours of Children Capture and Sequestration while I squirreled away in the attic.

*"Before significant progress can be made on any of these fronts, however, we will have to adopt a new attitude toward petroleum—a conscious decision to place basic values and the good of the country ahead of immediate personal convenience."*

–Michael T. Klare
"Blood and Oil", 187

**Introduction**

According the United States Census Bureau there were an estimated 227 million people over the age of 18 living in the United States in July of 2007.[3] Additionally, as of 2006 there were over 250 million vehicles registered in the United States.[4] Even when non-drivers and inoperable vehicles are accounted for, with this number of drivers and vehicles in the United States it is not surprising that the main consumer of petroleum in the United States is the transportation sector. When considering those statistics, a 33% increase in at-pump petroleum prices from, for example, $3.00 per gallon to $4.00 is more than a mere three to four more dollars at the pump at each stop. When multiplied over such a large quantity of drivers operating that number of registered vehicles, a 25% increase in fuel prices has a significant impact on the economy of this country. This is without even considering the broader impact on other economic factors such as the transportation of goods. Such increases can be considered to have the same affect on the consumers as that of a tax. Because the United States imports more than half of our oil, this "temporary tax" revenue goes mainly to the foreign oil producers. The causes of these price fluctuations are what is at the heart of the matter. One cause is our dependency on certain nations for a stable flow of oil. Another cause is our dependency on oil itself in our national energy profile. Commensurate with our addiction to oil, the citizens of the United States have a certain level of denial regarding its clear danger and subsequently a lack of awareness that

change is needed. Therefore, the market isn't going to correct this problem. Some level of government intervention is required to achieve this change.

One function of federal government is to provide stable infrastructure to it citizens. Although energy is not technically infrastructure, it is inherent in every aspect of life. A stable supply of energy ensures a certain level of health and welfare. The United States must have the ability to provide energy for heating the Midwest in the dark of winter, to provide electricity to the Deep South during the hot summer months, and to provide emergency medical response throughout the nation, especially in the case of a mass casualty event. It is a matter of national security. Most importantly, concerning the ultimate security of the nation, the ability to prosecute wars depends on the nation's ability to obtain fuel. The ability to achieve the United States' military objectives will be at risk from the limited supply and permanently elevated high prices of oil. Diversification in both energy type and country source is the insurance the United States needs to mitigate the effects of a future global energy shortage on our security.

To understand what needs to be done, the energy security problem must be framed. Three areas require careful examination to ensure the United States will achieve tangible progress toward energy independence. Initially, I will describe the energy situation that we find ourselves in. Subsequently, I will examine several critical points that led to our current situation. I will then discuss what has kept us in this situation and what has prevented a natural transition from this tenuous position to one of more advantage. Finally, the last two steps will evaluate the efforts toward independence and propose actions to arrive at energy independence expressed in the form of proposed energy security policy.

## We Are Running Out of Oil: Peak Oil and the End of Oil

The most tangible evidence of the problem of the threat to our national security is recent extreme fluctuation of at-pump prices [see Figure 1]. Several key facts paint a dark future for petroleum based energy. The world's largest oil fields were all discovered more than 50 years ago. Several decades later, an alarming discovery trend became apparent. Since the 1960's, annual oil discoveries have decreased. The mark of an alarming problem became obvious twenty years later. Since 1980, annual consumption has exceeded annual new discoveries [See Figure 7]. To make matters worse, the global sources of oil are quite centralized. To date, more than 42,000 oil fields have been found. Despite this seemingly large quantity, the 400 largest fields contain more than 75 per cent of all oil ever discovered. This limited nature is not a unique characteristic to oil. All fossil-fuel energy sources; oil, natural gas, and coal will become more scarce as time progresses. The non-fossil-fuel Uranium is so plentiful in nature that a shortage is not of concern.[5]

Of all of the mined energy sources, oil has the highest demand and is getting more and more difficult to extract, refine, and get to market.[6] The world is in the midst of crossing the half way point in consumption of proven oil reserves. The discovery rate of new fields has dropped to a crawl unable to match pace with extraction rates despite the prediction of a large quantity of undiscovered oil fields [See Figure 7]. The historical maximum of oil discoveries has to be followed after some time by a maximum of oil production (the "peak").[7] The "peak" as predicted for the United States by M. King Hubbert in 1956[8] and realized in the early 1970s, will be a reality globally if it isn't already. Estimates of peak oil occurring are varied, ranging from as early as 2010 to as late as around 2100.[9,10,11] Some experts have even flatly denied the

existence of such a theory. Theories supporting peak oil, describe that it will be followed by anywhere from a steep, cliff-like decline to a gradual sloping decline in production and subsequent price increases as supply slowly runs out. The two major factors, which have continually caused error in past projections creating Cassandras of many of the experts, are the discovery of new oil fields and development of new extraction technology. In those cases, the predicted dates are continually adjusted. As mentioned above, oil discovery has slowed down. Hard evidence has shown that over the last 20 years, there has been a declining rate of oil field discoveries [See Figure 7].[12]

A potential bottleneck in energy supply is the ability to refine oil fast enough to keep up with demand. Globally, the current total refinery capacity is unable to handle the petroleum demand that accompanies the predicted global energy demand through 2030. This problem is compounded as India and China continue their massive growth [See Figure 6]. Furthermore, improvements in refinery capability have different meanings for developed than for developing countries. In the developed countries, building greater capacity infringes on the rights of the citizens of developed countries. The developing countries, whose citizens would most enjoy the finished good that a modern refinery in their country would produce, cannot afford to build them. Limited capacity to produce refined oil will have a near-term impact on the ability to get adequate volumes of oil to market. Peak oil will have an impact on future oil markets as oil prices rise to meet the cost of getting difficult to access oil to market. Both near- and far-term issues cause significant concern in a rapidly developing global economy as populations explode in India and in China.

Supply can be affected by a variety of factors. Some of these factors include political instability, outpaced extraction, transportation shortfalls, refinement limitations, and the natural peaking and decline of worldwide fossil-fuel reserves. In the near-term, it is more likely that restricted supply will result from the inability of the international market to keep up with the international demand. In order to prepare for eventual and unpredictable market behavior, it is critical for the United States to begin to diversify its petroleum suppliers.

**Most Oil in Unstable Areas**

Much of the global petroleum supply is located in countries who are politically unstable or who are unfriendly to the United States. While the United States is currently ranked third in the world for oil producers, it is the number one consumer of oil world-wide.[13] More to the point, along with being the number one consumer, the United States is the number one importer of oil in the world. It imports almost two and half times more than the next nation on the list, Japan.[14] This degree of dependency on imports has significant impact on the United States' energy security, especially when combined with the overwhelming percentage of oil in our energy portfolio.[15] The United States imports 34% of its fossil fuels, mostly petroleum. Of its imports, 54% is from OPEC members and 46% from Non-OPEC members. Of the total amount of oil imports, it imports 19% from Canada, 14% from each UAE, Mexico, and Saudi Arabia, 11% from Venezuela and Nigeria, 4% from each Algeria, Angola, and Iraq, and only 1% from Russia. While the diversification between OPEC and non-OPEC members is equally distributed, 95% of the United States' imported oil comes from these ten countries.

The top fifteen countries from which the United States imports oil include a preponderance of countries that are unstable or that have displayed an overtly negative attitude

toward the United States. Unfriendly countries such as Saudi Arabia, Russia, Iran, and Venezuela ranked in the top seven in 2009. Further down the list are the African countries of Nigeria, Algeria, Angola, and Libya.[16] Saudi Arabia and Russia have long led the world in petroleum production but their challenges are markedly different. Saudi Arabia has long enjoyed symbiotic relations with the United States. Saudi Arabia needs financial security and the United States needs energy security. Additionally, Saudi Arabia has always had the mature ability to control its flow as far as OPEC would allow them to. This gave them the ability to control supply and therefore the price of oil. Saudi Arabia's major risk is the internal unrest of its warrior tribes. This becomes more of an issue the more suspect their stated levels of reserves become. Russia on the other hand produces to its maximum capacity without regard to maintaining the ability to surge and without investment in infrastructure.[17] With regard to oil, Russia behaves like the mafia would if it were to run a country, focused on making a dollar today. The African countries generally suffer from common challenges. They are rife with internal violence usually competing over control of oil and diamonds.[18] Their infrastructure suffers as a result and they are unable to produce at their capacity with any level of certainty. The very survival of an oil market in some of the African countries is at risk on a daily basis. As evidenced, all of these major oil countries have specific sets of challenges in the world energy market. Their internal politics makes their ability to maintain a constant flow of fossil fuels resources unreliable.

Competition for resources throughout the world is more and more acute as competing nations enter into contracts locking in substantial guaranteed flow of fossil fuels over long periods. When there is significant political disruption in countries who export to the world

market, there will be a resulting spike in the price of oil either from a legitimate supply shortage or market panic due to the perception of the possibility of a supply disruption. With the increase in price of everything that matters in life, it is easy to draw the logical conclusion that if the price of oil escalates high enough for a long enough time, the United States' national security will be at risk. Our domestic dependence on fossil-fuels magnifies this effect since any increase in price of oil will affect the United States' energy market proportionate to the percent that our energy market is based on fossil-fuels.

**An Energy Portfolio Highly Dependent on Oil**

The United States' consumption of energy has outpaced production since the 1960s [See Figure 2]. This trend will be increasingly critical over the next 25 years if more and more energy is derived from fossil fuel sources. In 2007, the United States consumed 102 quadrillion BTUs of energy. Eighty-five percent of that total energy was from fossil fuels. Forty percent of the overall energy production came from petroleum, 24% from natural gas, and 23% from coal. The next most frequently used energy source was nuclear electric power, which provided eight percent of the total BTUs consumed in the United States.[19] These proportions are projected to continue well into the future [See Figure 5].[20] The United States' energy structure is heavily petroleum-dependent and disruptions of world-wide oil supply will have a significant impact on our economy.

The past events that led to our current situation will help project a way forward and provide a forecast to the possible effects of our plan. The essential step was made toward a world oil-standard when British Prime Minister Winston Churchill successfully converted the British fleet from coal burning to oil burning power plants during the First World War[21]. Around

the same time, the internal combustion engine began rapid development and proliferation. These two events marked the transition from the coal- to the oil-standard.

The course of oil dependence was set, however, in the 1930s when oil was struck in Bahrain. Critical momentum was gained in the area when Harry St John "Jack" Bridger Philby arranged for a company called SoCal to secure concessions in Saudi Arabia. This inevitably led to the symbiotic relationship between the United States and Saudi Arabia that lasted well into the late 20th century and early 21st century. The Kingdom of Saudi Arabia has come to rely upon dependable revenue from the oil to quell the rebellious factions within its borders.[22] In the 1920s, Ibn Saud struggled to unite the tribes now known as Saudi Arabia. His final and successful effort required the use of the ferocious Ikhwan tribes. Over time, even these tribes attempted to rebel against him, again threatening the strength of the union.[23]

Furthermore, during World War II, the Kingdom leveraged its control of this wartime-critical resource. It often made promises to sustain a regular supply in exchange for security from those countries. Early in the establishment of these relationships, Saudi Arabia tended to trust the United States over Great Britain due to the United States' refreshing business-oriented approach as opposed to the recent sour feelings from British colonial rule. In the early years the oil companies from the United States were not trying to encroach on Saudi Arabia's culture.[24] And so began the relationship and cheap oil for United States.

To carry the petroleum addiction from decade to decade as the global economy grew, the United States, through government policy, maintained a reputation for enjoying cheap at-pump fuel prices. While other countries throughout the world imposed steep taxes on the sale of

gasoline and diesel to offset pollution or to fund alternate energy projects, the United States took no such action. Americans have therefore become accustomed to cheap gas, to a fault.

In fact, this reliance on cheap gas has exacerbated the addiction to oil over the decades. Energy security and independence from oil has been a recognized issue since as early as the 1973-74 Arab oil embargo. Despite efforts by the government to reduce the dependence on oil, the economy of the United States is still significantly dependent on oil. In 1975, the United States established a set of standards to improve the fuel efficiency of vehicles through Corporate Average Fuel Economy (CAFE) standards.[25] These standards significantly contributed to the improvement of the gas mileage of today's cars and, consequently, to less consumption.

The construction sector of residential and commercial buildings has not seen the same aggressive application of energy efficiency that the auto industry has. There is no government regulation equivalent to CAFE standards that requires certain standards for building efficiency. The closest that the United States government has come was in 2005 when it created a new deduction for expenses incurred for energy-efficient commercial buildings. Furthermore, in 2007 the United States government set a goal of achieving zero-net-energy use for new commercial buildings constructed after 2025. Both moves lack the decisive action needed to truly lower the high energy consumption of our buildings.

A third point of consideration in the less than stellar efforts to gain independence is the actual generation of energy. In the 1990s and early 2000s, government regulations targeted the electricity producing plants that are coal based. While these measures were based on pollution concerns, the residual effects should have resulted in a fossil-fuel independent energy sector. Unfortunately, a loop-hole was exploited for many years involving the grandfathering of power

plants that were around when the regulation was set into motion. Many coal-fired power plants were allowed to remain in business until they had to be replaced due to age. In several cases, the power plants were simply gutted and upgraded internally at the lowest cost possible with new but still coal-based systems in order to avoid the costly new technology required by the regulation.[26] This cost efficient activity in the interest of financial gain is natural in the free-market system and is essential to the fabric of the American economy. But it is this exact behavior that has kept the United States on a collision course with an energy crisis for over thirty decades. A collision course of limited production and accessibility exacerbated by increased global demand.

## Limited Production and Accessibility

Long-term growth in energy demand across the globe is accelerating at an alarming rate with only momentary decreases in growth as the global economy surges and recedes in natural cycles. Even during the economic recession that began in 2008, India has maintained a growth rate of 5-6%. There will be escalating rates of growth globally in many developing countries once the world economy recovers. Energy demand follows closely behind economic growth. Following the current international economic slump, the reigniting of economies will inevitably reestablish the historically high demand for oil. This demand will face a restricted supply market due to world-wide limited transportation and refinement capability.[27,28] The trend over the decades will persist as "global oil demand is projected to rise from 83 million barrels per day in 2008 to 120 million barrels per day by 2030."[29] During the 1990s, low prices caused significant complacency and a resulting low level of investment in refinement capability. In the United States alone, the number of refineries decreased from 324 in 1981 to 149 in 2007 [See Figure 8]. Today, there is significant world-wide political resistance to closing the gap on refinement

capability.[30] The not-in-my-back-yard syndrome is problematic in many communities. While there is still approximately 15% more operating capacity in the United States, it will be difficult for the global energy sector to build enough refineries quickly enough to keep up with global demand. Furthermore, existing capabilities of the refineries today are not adequate to process the heavier and higher sulfur content of oil that is characteristic of the oil that is difficult to access.

Additionally, the extraction of oil has become more and more difficult for two reasons: The resistance from environmental lobbying groups to the development of new oil fields, and the rapid depletion of current fields. Rapid depletion has made extraction more and more difficult, requiring such techniques as injecting water and natural gas back into the oil fields to increase their production. These techniques are signs that the oil fields have reached their peak and are in their last dying throes of survival. As oil fields around the globe reach their limits, the industry will seek more and more difficult oil. The effect will be a gradual but persistent price increase.

The problem that confronts the United States and the global economy for that matter is an addiction to oil that began in the early 1900s and is running square into a near-term limit of supply due to atrophied oil producing infrastructure. Now that the problem has been framed, it must be addressed.

## What Have We Done So Far

Ever since the oil embargo in the mid-1970s, the United States has been aware of the need to decrease the oil dependence. Tangible results over the last three decades have shown that efficiency measures have worked [See Figure 3]. [31] Every few years the government addresses the energy issue from a lens of contemporary issues. In 2005, the United States government addressed the issue of energy security and pollution through the Energy Policy Act

of 2005. Two years later, the Bush administration modified this act and called it the Energy Independence and Security Act of 2007. This change in name indicated a shift toward acknowledging a need for a policy that addresses the need for energy security. The proof as to whether this is simply a name change or a real move toward energy security lies in the details of the Act.

In the Energy Independence and Security Act of 2007 (S.R. 6) or EISA07, signed December 19th, 2007, the federal government modified and expanded the Energy Policy Act of 2005 by taking measures to move toward an energy secure economy within the next few decades. Funding was directed toward various aspects of energy security to include public education to begin the paradigm shift, development of innovative non-fossil fuel energy sources, and more efficient use of existing fossil fuel systems.[32] Examples of steps taken include the appropriation of funds at various pressure points in the renewable energy industry and authorization to appropriate $500 million for fiscal years 2008 through 2015 for the pursuit of advanced biofuels technology.[33] Between 2007 and 2008 alone there was an 18% increase in funding for advance biofuels. In the area of advanced photovoltaic technology, the EISA07 authorized the allocation of between $15 million for FY2008 and $70 million for FY2012[34].

When comparing the funding for biofuels to that of solar farms, it is clear that the federal government considers biofuels a more viable renewable energy source than solar generating farms. Furthermore, wind-produced energy was only mentioned in a simple by-item listing under types of renewable energy. The simple review of the EISA07 and EPA05 reveal unimpressive attempts to inspire a national paradigm shift away from a petroleum-based energy portfolio.

The newly adopted fiscal policy of the Obama administration seems to give energy security its due share of benefits from the more than $800 billion dollar American Recovery and Reinvestment Act of 2009. The energy portion alone consisted of approximately $50 billion dollars. The largest partition of that $50 billion was $11 billion, which was appropriated for development of an electric smart grid to digitize power distribution and improve the grid's efficiency. To put this improvement into perspective, a simple five percent improvement in efficiency of the electric grid equates to emissions reductions the equivalent of 53 million vehicles.[35] Six billion dollars was split between renewable and electric transmission technologies in the form of loan guarantees. Six billion dollars was also directed toward the cleanup of nuclear waste. Surprisingly, there was no specific mention of storage of existing and future waste, an issue that many nuclear development entrepreneurs were focused on. Notably, $2 billion dollars was directed toward manufacturing of advanced car battery or traction, systems. Seven hundred million dollars was directed to electric vehicle programs, half of which went to federal programs and half to electric vehicles in general, implying encouragement of the development of private electric vehicle. Other than the above mentioned allocations, the rest of the partitions were inconsequential, hovering in the four to five hundred million dollar ranges.

The Recovery Act of 2009 did not introduce elements that will bring the nation any closer to being energy independent any more than did the two previous bills. Of significant importance was the fact that there was no mention of biofuel development. Each window that is opened by the federal and state governments through incentives provides the impetus for more and more companies to take more risk and venture into alternative energy technology. But, until

more large-scope incentives are provided, diversification toward a robust renewable base will not occur.

The efforts of the EPA05, later the EISA07, and now the Recovery Act of 09 are not enough to cause a paradigm shift in the American energy mentality. Much more needs to be done. Despite the detailed layout in ESIA07 of specific dollar amounts to be provided as incentives to residential and commercial sectors, the total amounts allocated by the federal government are meager and nowhere close to what is needed to inspire widespread application of non-fossil-fuel energy technologies. There are significant shortfalls in each of these pieces of energy legislation. The Annual Energy Outlook 2009 (Early Release) (AEO09) predicts that in 2020 biofuels' availability will fall short of the 36 billion gallon Renewable Fuels Standard (RFS) target.[36] The Department of Agriculture (DoA) attempted to mitigate this problem by issuing loans. The DoA provided an $80 million loan in January of 2009 to Range Fuels, Inc who predicted that their biofuel plant will be online as soon as 2010 and, at full capacity, will produce over 100 million gallons of ethanol.[37] Again these efforts will not do enough to promote growth in the renewable energy market. One hundred million gallons of ethanol represents merely a drop in the ethanol bucket.

The meager results of the Department of Agriculture's actions reflects the unrealistic projections of the AEO 09. Those projections count on the success of the EISA07 to spur the production of unachievable amounts of biofuel. From the EISA07 mandates, the AEO09 assumes that "petroleum-based liquids consumption is projected to be flat as biofuels use grows."[38] Without more financial incentives and expenditure of political capital, EISA07 objectives to reduce petroleum-based liquids cannot be met.

An often ignored element of non-fossil energy is that of nuclear generated electricity. Of the 436 total global nuclear reactors, there are approximately 104 nuclear reactors in the United States. Only eight percent of the United States energy comes from nuclear power. The 59 Nuclear generating stations of France provided 78% of France's electricity output in 2003. France's most recent development occurred in the late 1990s with the construction of their largest four reactors.[39] Two of these reactors are the largest in the world. The last one came on line in 2002. Just one of France's newest and largest reactors produces more electricity than all of the electricity generating stations, nuclear and non-nuclear, in both Vermont and Rhode Island.[40] The incredible capabilities of the newest reactors in the global energy sector show optimistic potential for nuclear power's replacement of petroleum fuels. Nuclear power has earned a negative connotation among the American public but is a source of energy that requires serious consideration. It can contribute significantly to the future energy security of the United States as a primary source of diversification of energy.

Much of the opposition to nuclear power revolves around the misperception that nuclear power is dangerous. Two examples are frequently cited by the opponents to nuclear power; Three-mile Island and Chernobyl. In the Three Mile Island incident, there was no radiation leak and there were no casualties, not even injuries.[41] Due to tightly held information and even misinformation by the Former Soviet Union, it is difficult to determine with any accuracy the exact number of fatalities that occurred but the overall magnitude can be estimated. The initial casualties in Chernobyl included approximately 50 people killed in the immediate aftermath of the catastrophe, mainly in the firefighting effort, and thousands of cancer cases that can be

attributed to the after effects of the fallout. For instance, although 4000 children developed thyroid cancer in the region only 9 have died.[42]

Chernobyl was the worst example of design in the realm of nuclear power from the poor functional design of automatic emergency procedures to the lack of sound structural design to protect from radiation leaks. Additionally, there is evidence that poor decision making by the management had much to do with the cause and magnitude of the accident.[43] Any casualties related to energy are unfortunate but if Chernobyl is the worst and only nuclear accident resulting in fatalities in the history of nuclear power, sixty casualties are not significant in the grand energy scheme especially considering the impact of coal-fired power plants on the health of populations around the world.

After 58 years since the original nuclear power plant went online producing electricity, the annual death rate due to accidents at power plants is about one per year. If one draws the conclusion that this many casualties is an outrage and grounds for not employing nuclear reactors in our energy plan, then one must also consider that the average number of deaths in the United States related to coal-fired power plants. While the deaths in the power plants themselves are negligible, mining deaths are a different story. In coal mining alone, there was an average of 33 deaths per year in the United States from 2005-2008.[44] In China, over 3,786 coal miners were killed in 2007.[45] The 2007 results represented a ten percent improvement on 2006.

Another major issue with nuclear power is the ability to store and deal with waste. It is difficult to ensure the protection of the environment and the human race from the effects of the radiation. Additionally, there is significant risk of the waste falling into the hands of terrorists. Technological developments in storage have reduced the dangers and challenges of nuclear

waste.[46] Unfortunately, the Obama administration put hold on many years of work and billions of dollars of investment, when it announced that work on the Yucca Mountain storage facility would not go forward.[47] This is clearly a signal from the government that energy security and reduction of oil dependency is not a priority. On the other hand, developments in fuel packaging promise to result in less waste from future reactors.[48] But again, this technology is nowhere near being ready for use and will not be until around 2030, even optimistically.[49] Nuclear power, while a very attractive contributor to energy diversification will require significant government assistance. The progress made in France can serve as a good example for our next moves toward nuclear power improvements.

## Act Now In Order To Be Ready

With low demand and the resulting low stress on the global petroleum infrastructure, gasoline prices are at a relative low. With low fuel prices and economic decline in all sectors, a general feeling of consumer apathy is setting in. This is exactly the moment in time to strike. The nation needs to begin now to make progress to achieve national energy security within the next 25 years. Despite the onset of consumer apathy, the pain of extremely high gasoline prices is still in the memory of the consumers. During a time when the government is pulling out all stops and shifting from a monetary policy to fiscal policy, there is significant money available to stimulate development of a diversified energy profile. The government can go far through incentives and through punitive action to shape the energy profile of the nation but it can also make significant strides to develop a sound base of imports of the oil that remains in our balanced portfolio.

## Source Diversification

In 2007, the United States' 102 quadrillion British Thermal Units (BTUs) of consumed energy was comprised of 40% petroleum, 24% natural gas, 23% coal, 8.4% nuclear-generated energy, and 7% renewable sources of energy [See Figure 4]. The unusually high amount of oil, natural gas, and coal relative to nuclear and renewable sources of energy used to meet its energy needs puts the country at great risk when a worldwide shortage of fossil fuels becomes imminent.

To achieve a balanced and diversified energy portfolio by 2030, it is critical for the United States to begin taking steps today. Immature technology in the both wind and solar sectors, the unwilling mindset of the consumer, and the laborious bureaucratic and political process inherent in the energy industry require early planning, constant pressure, and a consistent message to achieve the goal within the next 20 years. For instance, it takes 15 years to develop a nuclear power plant.[50]

## Nuclear

Despite all of the optimism about better packaging of fuel and high capacity nuclear power plants that can produce enough electricity, even for additional purposes such as the creation of hydrogen, the costs are too great. The cost of electricity generation from the building of this new generation of power plants exceeds the cost of electricity from other means and would require significant cost cutting or government subsidies to make up the difference in costs.[51] The simple fact of the energy to weight ratio of nuclear power should be enough for the government to understand that nuclear power should play a major role in the United States' energy portfolio. If subsidizing the cost of nuclear power cannot be done economically then, carbon taxing from the political perspective needs to be strongly enforced and all loopholes need

to be removed. This is even at the risk of increases in the price of electricity in the near term. Either political or economic capital must be spent. This is just one of many examples in the energy security realm in which change is not easy. A clear message must be sent to the nuclear energy industry in the form of government support on handling nuclear waste. The Yucca Mountain facility must go ahead as planned.

**Renewable Energy Sources**

While renewable energy will only provide a small portion of any energy portfolio, its development is critical to any government plan to offset the risk of a disruption in petroleum supply. There is significant resistance against renewable energy from many industries. They resist through lobbying to keep the money away from the renewable sector. There are many alternatives to petroleum, but all face political and economic challenges that will not allow them to become legitimate contributors to the energy portfolio in the near term. From the movie "Who Killed the Electric Car?" it is clear that strong political powers come to play when any one renewable source threatens the livelihood of the petroleum-based, internal combustion engine.

Much of the talk about achieving higher miles per gallon (mpg) efficiency for vehicles, establishing building efficiency, using efficient light bulbs, and talking to the American public about consuming less oil is the result of the environmental lobby groups limited by their agenda of environmental protection as opposed to imagining what could be – an global energy market less dependent on petroleum and foreign control. These groups have turned this issue into a "tree hugger" versus the "big company" battle instead of joining forces with the innovators and moving toward ridding our dependence on oil. With the right premise these groups could change

the energy landscape of this country and of the world, but instead they lobby for and bicker over increased fuel efficiency by 2020.

Only a severe economic blow that results in sustained, unrecoverable losses both by the automotive industry and the oil industry simultaneously will open the way for the successful and sustained development of technologies such as electric vehicles, hydrogen combustion, hydrogen-electric vehicles, solar generated electricity, and wind turbine based electricity. To defeat the lobbyist power of the oil and automotive industries, the lobbyists' cash flow and influence have to be incapacitated. For now the sustained rate of government spending on grants and loans to develop technology will be the only course available to the United States.

## Efficiency Standards

In 1975, CAFE standards were introduced in the Energy Policy Conservation Act of 1975 with a stated goal of doubling energy efficiency by model year 1985.[52] It started by requiring an average of 18 miles per gallon (mpg) for passenger cars by 1978. Figure 9 shows the detailed progression of the standard to the 27.5 mpg standard of today. In 1995, the industry began to exceed the 27.5 mpg regulation and produce a fleet that was more efficient then required. Today, the fleet average is 29.5 mpg.[53] This overachievement was likely driven by consumer demand rather than industry performance. As noted, the 27.5 mpg mentioned above is for passenger cars. The "combined" average which includes light trucks is 22.5 mpg. This difference is important because the EISA07 has laid out a requirement of 35 miles per gallon for the "combined" category by 2020, a 40% increase over the 22.5 mpg. To be effective, the industry must be required to increase the efficiency incrementally each year. Over 11 years the

mpg would have to increase by 1.1 mpg each year to achieve a 35 mpg requirement. This is a significant departure from the stagnant standard of 22.5 mpg over for the last 25 years.

**R&D efforts toward innovative technologies in transportation**

Another approach to reducing fossil fuel dependence is to focus on replacing the transportation sector's consumption of petroleum with another fuel. The 102 quadrillion BTUs consumed by the United States are generally distributed evenly among the sectors of the economy: 21% Residential, 18% Commercial, 33% Industrial, and 29% Transportation [See Figure 4].[54] The critical information these numbers do not take into consideration is that the transportation sector is primarily fueled by liquid fossil-fuels and is therefore an isolated yet challenging target in the effort to diversify our energy sources. Furthermore, if vehicles operate on hydrogen combustion, the hydrogen can be created by surplus nuclear-generated electricity, especially considering the next generation of nuclear power plant technology that will be able to produce the surplus electricity needed to convert water into hydrogen.[55]

In light of the considerations presented in this paper, a balance of 15% petroleum, 30% natural gas, 20% coal, 25% nuclear power, and 10% renewable is recommended. In order to achieve a well diversified energy portfolio, government provided incentives to develop alternative, non-fossil sources of energy must expand to influence the greatest population possible. Tax incentives for private home owners and corporations need to more closely approach 100% of expenditures taken on by those interested in entering the renewable energy market as opposed to the simple 30% as allocated now. Additionally, severe penalties for coal and oil consuming industry need to be well placed in legislature followed up by the means with which to implement them. Once the gears are in motion to get the nation's portfolio on its way

to diversification, the United States government needs to focus its elements of national power on ensuring the newly apportioned slice of imported petroleum is dependable.

### Country Diversification

A concerted effort from the diplomatic and economic elements of national power will ensure that our oil imports are secure and the likelihood of disruption is minimal. A focus on assisting the African nations with their infrastructure development and training of their security forces will bolster their contributions to the global oil market. In order to facilitate international stability, United States' diplomatic efforts should focus on the strain between Russia and its neighbors. Russia would do well to embrace a potentially positive relationship by establishing a regional organization and competing with OPEC. Continued relations with Russia focusing on their ability to maintain a reserve and on turning their profits into infrastructure investments need to be priorities to ensure sustained contributions to the global oil market continue unchecked. [56]

Despite the troubled relations with Venezuela and Iran, diplomatic and economic discussions will help ensure that these oil producing countries continue to contribute their share to the OPEC efforts. Furthermore, discussions and cooperation with Iran on their nuclear program will further ensure that they have energy security while not permitting them to establish a nuclear weapons capability any further than they already have. One proposal is to establish an arrangement with Iran in their pursuit of nuclear power that both assists them in developing an energy source and controls the handling of potential weapons grade nuclear waste. The creation of a one-for-one exchange process can provide useable uranium for energy creation but ensure the return of waste to prevent development of weapons.

An international issue that can significantly improve energy security worldwide is the reduction of the practice of natural gas flaring. Over 150 billion cubic meters of natural gas are flared or vented annually.[57] When looking at the US Energy Information Agency's statistics, this is approximately equivalent to the combined annual gas consumption of Germany and France.

Often the question of policy is whether to pull from OPEC or non-OPEC sources and how well balanced our import structure is from each of those categories. Since oil is a world-wide commodity with multiple suppliers providing oil to the market with their own set of strings attached, it is in the United States' best interest to bolster all markets, OPEC and non-OPEC, alike, specifically focusing on infrastructure development of countries within these two categories that are rich in reserves but poor in extraction and transportation capability. OPEC and non-OPEC groupings have capabilities and limitations that need maximizing or mitigation to ensure adequate availability of oil to the world market.

There are significant issues with non-OPEC producers that need to be considered to understand the best way forward in developing a sound energy security policy through achieving diversification of oil supply. Significant development projects between and within OPEC members are adequate enough to ensure that the mature organization of OPEC will continue to maintain its ability to produce oil at competitive rates. Additionally, these projects help maintain a reserve base to stabilize supply and therefore prices so long as there is oil to extract. The United States should expend diplomatic efforts to develop a competitive counter-organization to OPEC among the non-OPEC members such as Russia and the other former Soviet Union countries.

Significant price spikes often drive initiatives within importing countries to increase fuel efficiency in all sectors and even to develop alternative sources of energy that displace the use of fossil fuels. Although lucrative in the short term, high prices can affect a petroleum exporting country negatively in the long run in the form of decreased overall demand. This works both ways and will therefore have a reflexive effect in developing alternative sources of energy and increasing energy efficiency. Our efforts to decrease consumption of oil will have a negative impact on countries that rely on the oil revenue. It is critical that these effects are considered in policy development.

A balance of imports from countries who have the most reserves and offer modest prices needs to be achieved to mitigate turbulence in oil supply to the global market. While this proposal will involve trade with countries who do not enjoy favorable trade relations with the United States, diplomacy matched with economic sanctions can be leveraged to established modified relations with these countries.

## CONCLUSION

Real money and policy must be provided as incentives for the development and proliferation of non-fossil fuel alternative energy technology. As we navigate our way through the treacherous waters of government involvement in open market operation economics, we must acknowledge that energy security is not about the environment rather it is about our independence, our freedom, and our survival as a nation. Thankfully, the parallel environmental effort is currently helping the struggle to establish energy security. Significant investment and

reduction of bureaucratic resistance to nuclear power is essential to give this viable energy source a greater share of the United States' energy portfolio.

Even after we achieve an acceptable level of fossil-fuel independence, petroleum will still be required to create a non-fossil fuel energy infrastructure; from the plastics of the wind turbines to the cells of the solar farms. If we delay in our efforts to develop technology that has longevity and a respectable level of output, we run the risk of not having the required level of affordable fossil fuels to develop alternative energy infrastructure at a time when it is desperately needed.

Energy security requires a well-coordinated and projected energy policy. It is an almost intangible objective especially when a massive government grapples with its construct against strong opposition from a stubborn business sector with daunting financial influence and a desire to maintain an already proven and well-developed industry.

# Tables and Figures

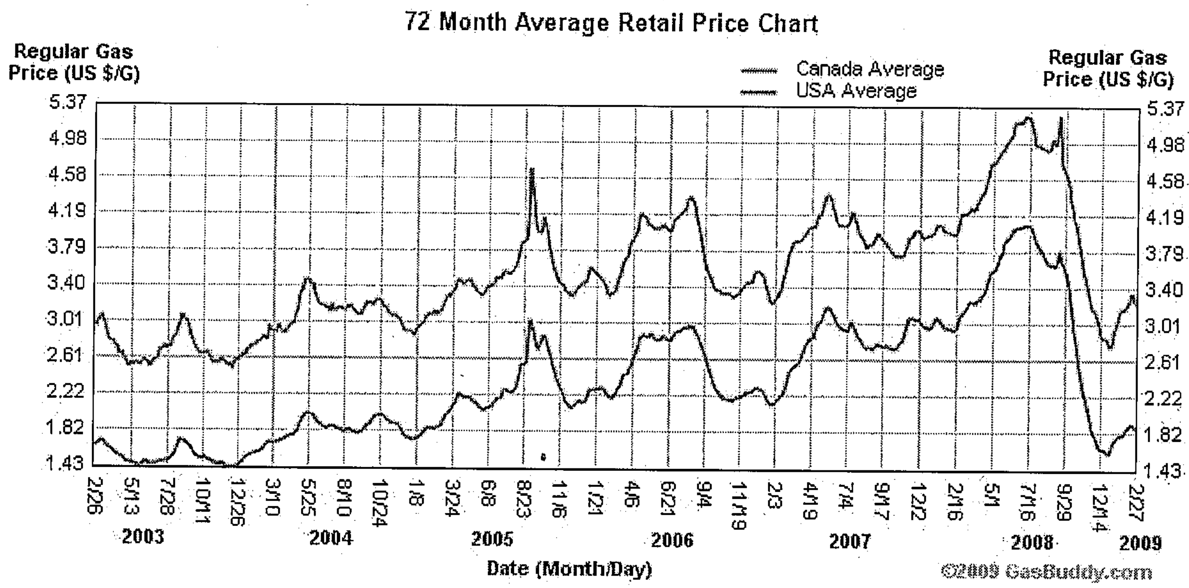


Figure 1. 72-month Average Retail Price Chart for Gasoline in the United States as of February 27, 2009 (Source: GasBuddy.com).

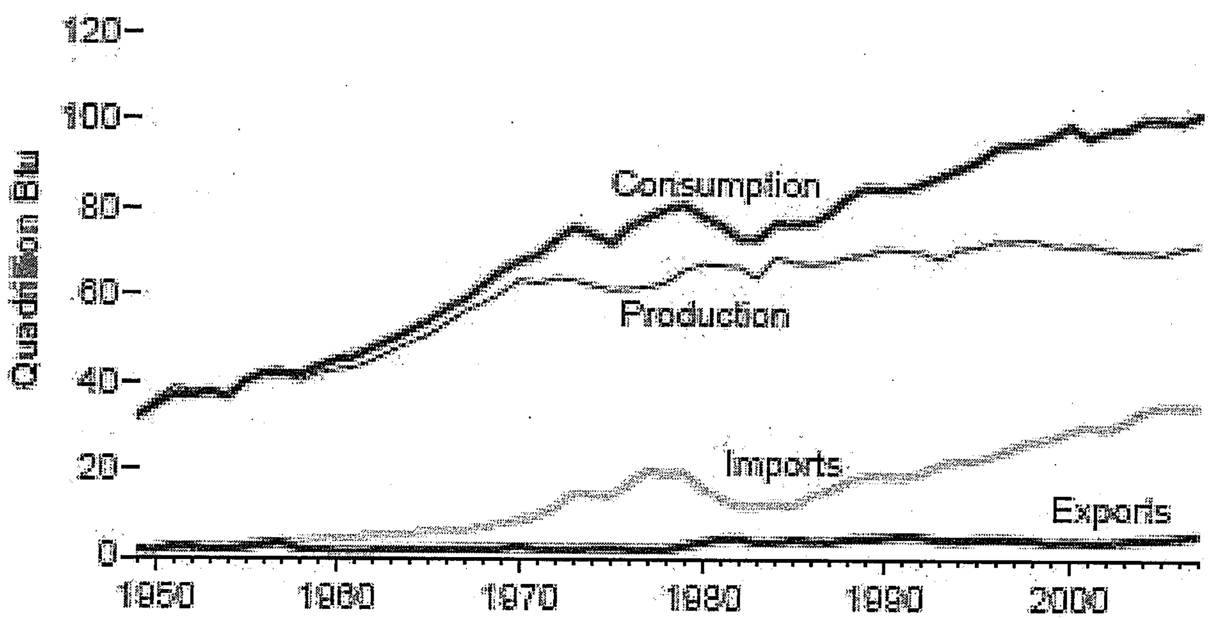


Figure 2. United States Primary Energy Overview. The United States was self-sufficient in energy until the late 1950s when energy consumption began to outpace domestic production. At that point, the Nation began to import more energy to fill the gap. In 2007, net imported energy accounted for 29 percent of all energy consumed. (Annual Energy Review 2007. June08)

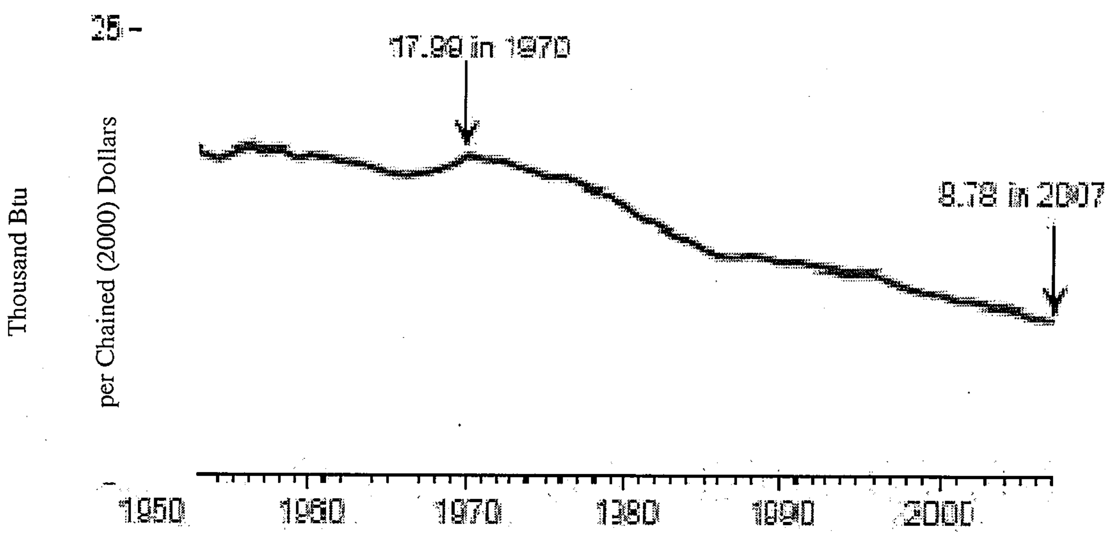


Figure 3. <u>Energy Consumption per Real Dollar of Gross Domestic Product</u>. After 1970, the amount of energy consumed to produce a dollar's worth of the Nation's output of goods and services trended down. The decline resulted from efficiency improvements and structural changes in the economy. The level in 2007 was 51 percent below that of 1970. (EIA. AER 2007. Page xix. also http://www.eia.doe.gov/emeu/aer/ep/ep_text.html)

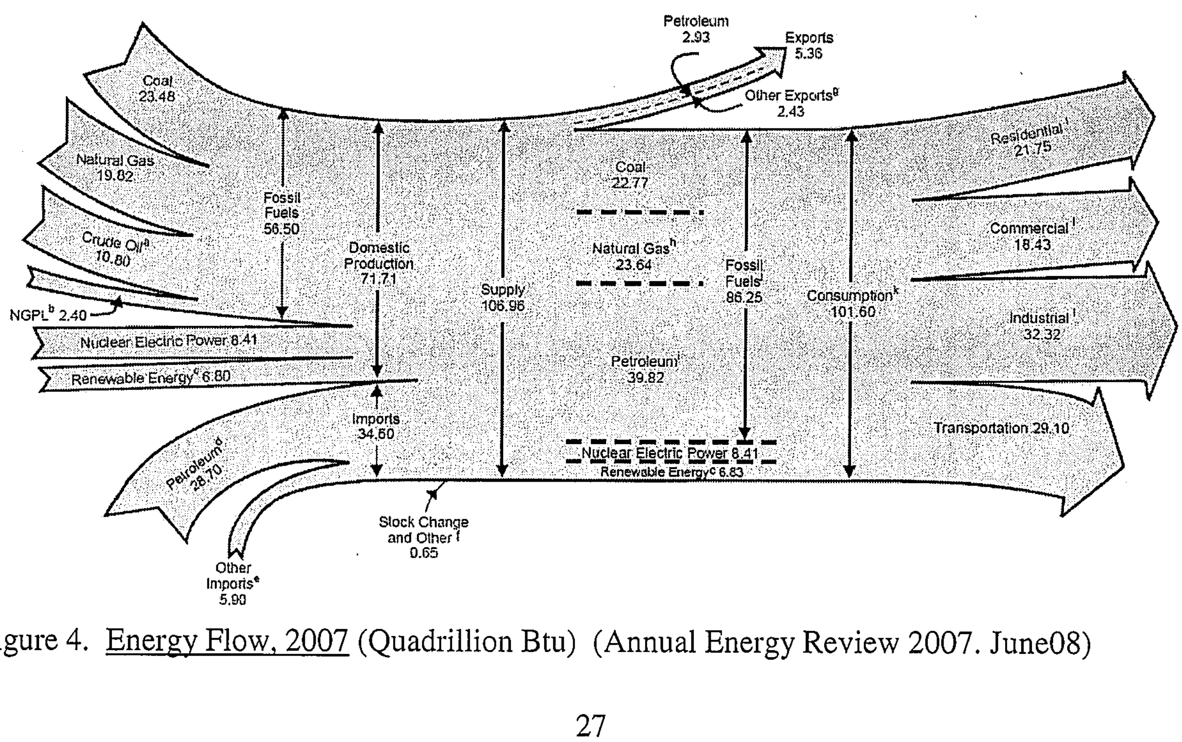


Figure 4. <u>Energy Flow, 2007</u> (Quadrillion Btu) (Annual Energy Review 2007. June08)

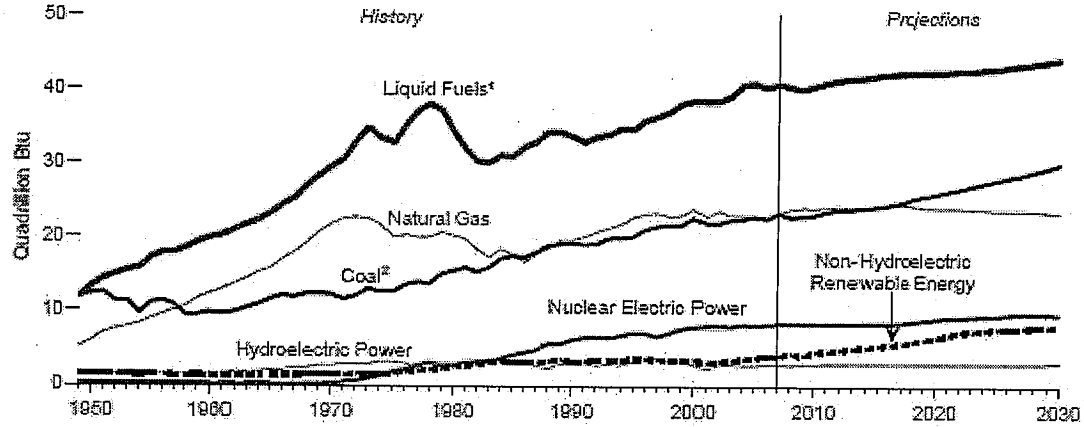


Figure 5. Energy Consumption History and Outlook, 1949-2030. While the Nation's energy history is one of large-scale change as new forms of energy were developed, the outlook for the next couple of decades (assuming current laws, regulations, and policies) is for continued growth and reliance on the three major fossil fuels—petroleum, natural gas, and coal—modest expansion in renewable resources, and relatively flat generation from nuclear electric power. (Source: Energy Information Administration (EIA). Annual Energy Review 2007 (AER07) . June 08. Page 22)

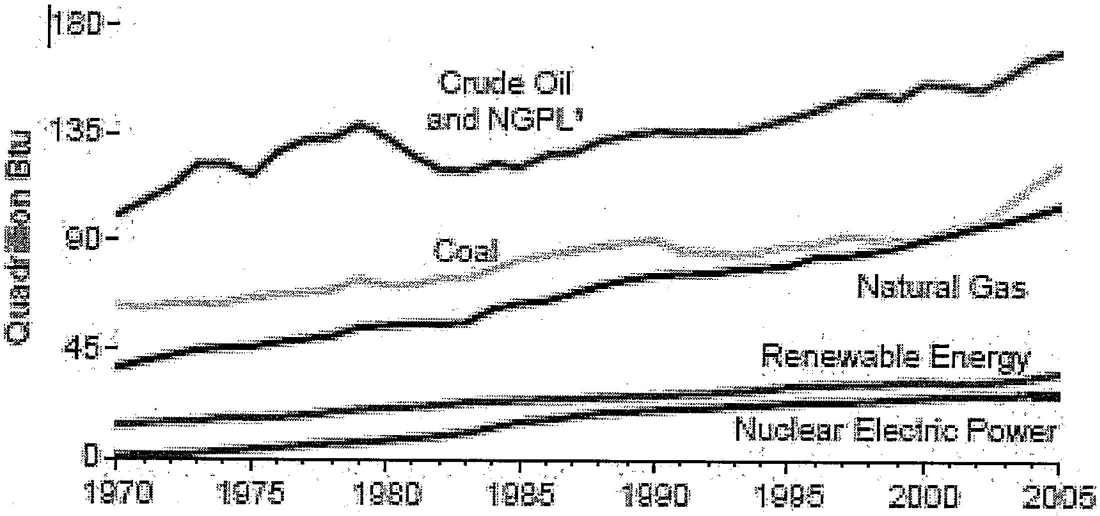


Figure 6. World Primary Energy Production by Source. From 1970 to 2005, world primary energy production grew by 114 percent, reaching 460 quadrillion Btu in 2005. Growth occurred in all types of energy. In 2005, fossil fuels accounted for 86 percent of all energy produced worldwide, renewable energy 8 percent, and nuclear electric power 6 percent. (Source: EIA. AER07, June 08. Page 36)

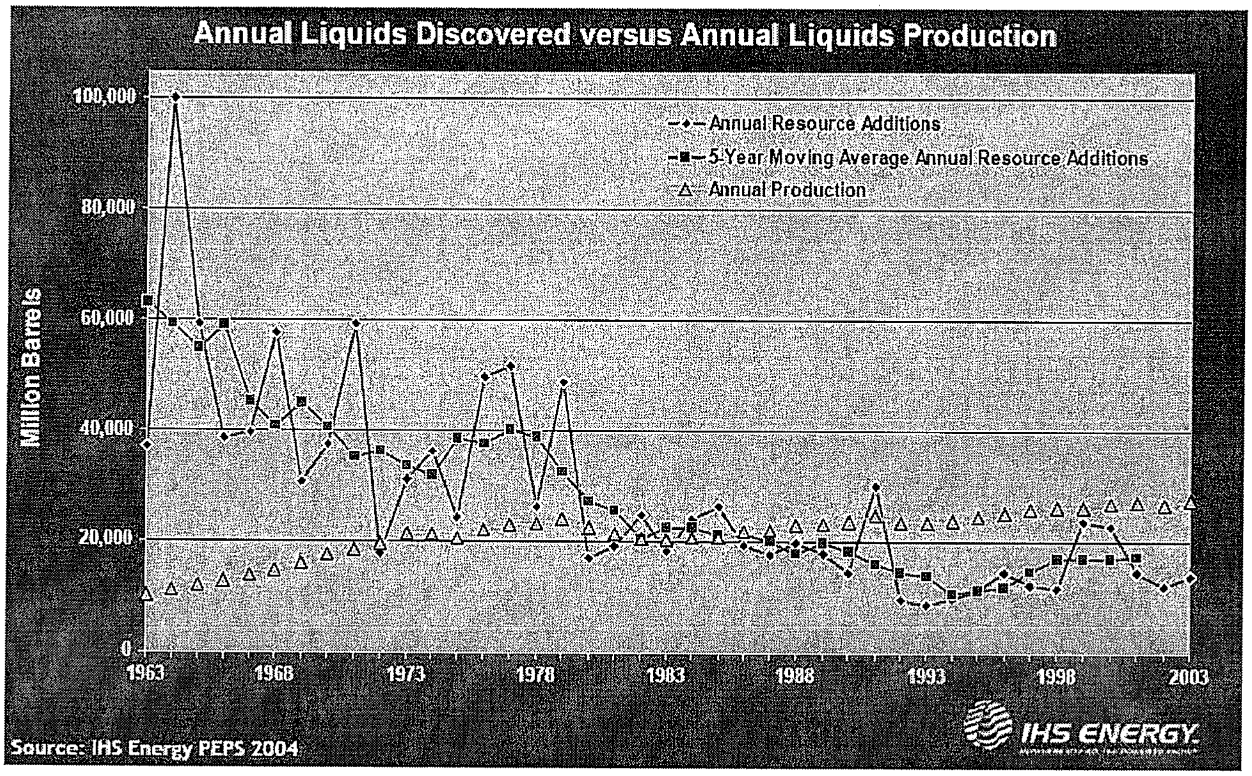


Figure 7. Discovery and production trends in the world from 1963 to 2003. (Source: Information Handling Services (IHS) Energy Petroleum Economics and Policy Solutions (PEPS) 2004)

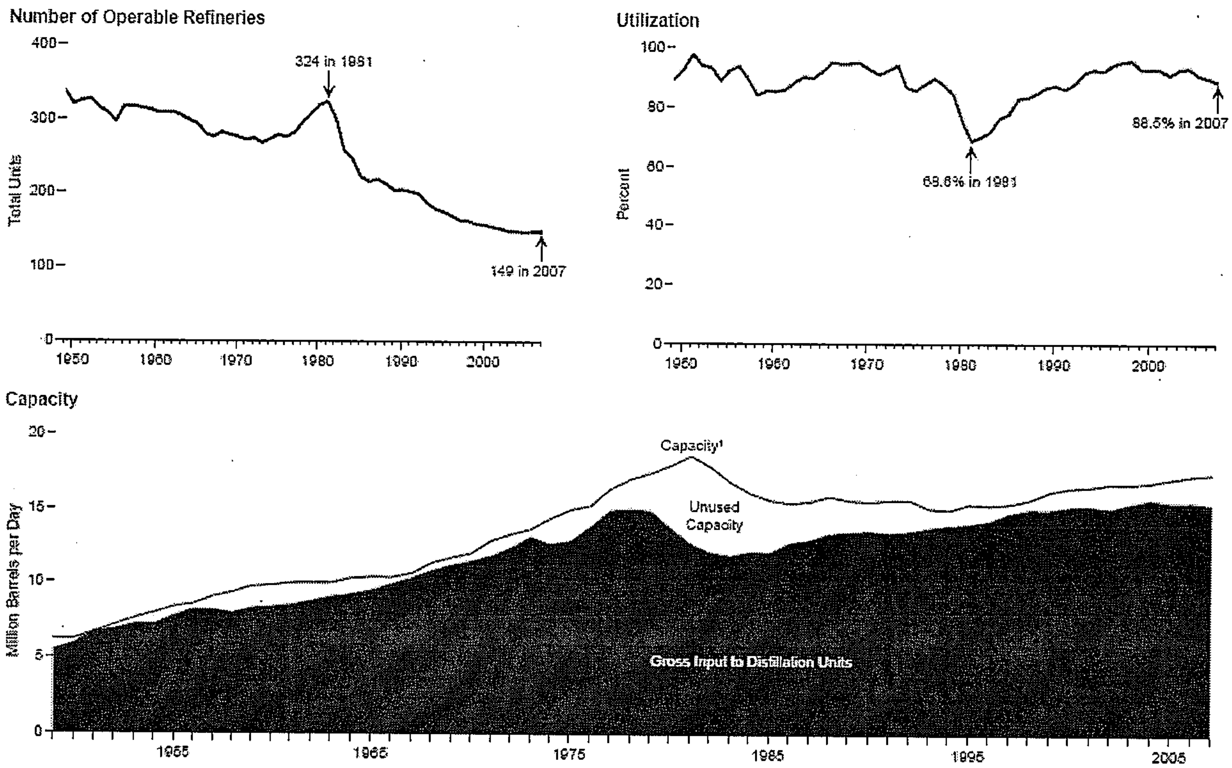


Figure 8. United States Refinery Capacity and Utilization, 1949-2007. (Source: Annual Energy Review 2007)

| Fuel Economy Standards for Passenger Cars and Light Trucks Model Years 1978 through 2007 (in MPG) | | | | |
|---|---|---|---|---|
| Model Year | Passenger Cars | Light Trucks (1) | | |
| | | Two-wheel Drive | Four-wheel Drive | Combined (2), (3) |
| 1978 | 18.0 (4) | ... | ... | ... |
| 1979 | 19.0 (4) | 17.2 | 15.8 | ... |
| 1980 | 20.0 (4) | 16.0 | 14.0 | ...(5) |
| 1981 | 22.0 | 16.7(6) | 15.0 | ...(5) |
| 1982 | 24.0 | 18.0 | 16.0 | 17.5 |
| 1983 | 26.0 | 19.5 | 17.5 | 19.0 |
| 1984 | 27.0 | 20.3 | 18.5 | 20.0 |
| 1985 | 27.5(4) | 19.7(7) | 18.9(7) | 19.5(7) |
| 1986 | 26.0(8) | 20.5 | 19.5 | 20.0 |
| 1987 | 26.0(9) | 21.0 | 19.5 | 20.5 |
| 1988 | 26.0(9) | 21.0 | 19.5 | 20.5 |
| 1989 | 26.5(10) | 21.5 | 19.0 | 20.5 |
| 1990 | 27.5(4) | 20.5 | 19.0 | 20.0 |
| 1991 | 27.5(4) | 20.7 | 19.1 | 20.2 |
| 1992 | 27.5(4) | ... | ... | 20.2 |
| 1993 | 27.5(4) | ... | ... | 20.4 |
| 1994 | 27.5(4) | ... | ... | 20.5 |
| 1995 | 27.5(4) | ... | ... | 20.6 |
| 1996 | 27.5(4) | ... | ... | 20.7 |
| 1997-2003 | | | | No Change |
| 2004 | 27.5(4) | ... | ... | 20.7 |
| 2005 | 27.5(4) | ... | ... | 21.0 |
| 2006 | 27.5(4) | ... | ... | 21.6 |
| 2007 | 27.5(4) | ... | ... | 22.2 |

Figure 9. Fuel Economy Standards for Passenger Cars and Light Trucks Model Years 1978 through 2007 (in MPG). (Source: National Highway Traffic Safety Administration. Automotive Fuel Economy Program Annual Update Calendar Year 2003)

1. Standards for MY 1979 light trucks were established for vehicles with a gross vehicle weight rating (GVWR) of 6,000 pounds or less. Standards for MY 1980 and beyond are for light trucks with a GVWR of 8,500 pounds or less.
2. For MY 1979, light truck manufacturers could comply separately with standards for four-wheel drive, general utility vehicles and all other light trucks, or combine their trucks into a single fleet and comply with the standard of 17.2 mpg.
3. For MYs 1982-1991, manufacturers could comply with the two-wheel and four-wheel drive standards or could combine all light trucks and comply with the combined standard.
4. Established by Congress in Title V of the Motor Vehicle Information and Cost Savings Act.
5. A manufacturer whose light truck fleet was powered exclusively by basic engines which were not also used in passenger cars could meet standards of 14 mpg and 14.5 mpg in MYs 1980 and 1981, respectively.
6. Revised in June 1979 from 18.0 mpg.
7. Revised in October 1984 from 21.6 mpg for two-wheel drive, 19.0 mpg for four-wheel drive, and 21.0 mpg for combined.
8. Revised in October 1985 from 27.5 mpg.
9. Revised in October 1986 from 27.5 mpg.
10. Revised in September 1988 from 27.5 mpg.

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